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THESIS

IMPLEMENTING READINESS BASED SPARING IN THE UNITED STATES MARINE CORPS BY ANALYZING THE UNITED STATES ARMY'S IMPLEMENTATION PROCESS

by

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In 1985, the Secretary of Defense directed the services to adopt a weapons management inventory concept that allows readiness and cost to be incorporated into setting inventory levels. The plan is laid out in the Department of Defense's Secondary Item weapon Systems Management Concept. The key concept is increasing weapon system readiness at lower costs. Today, this weapons system management concept is known as Readiness Based Sparing (RBS) and has been implemented in all of the services with the exception of the Marine Corps.

The Marine Corps has started to progress toward RBS by chartering studies by the Center for Naval Analysis including a review of RBS requirements and the situation of the present state of logistics systems and data collection. CNA's conclusions suggest a difficult road in implementing RBS due to inaccurate data collection. It is recommended that the Marine Corps examine the Army's implementation process due to weapon system commonality and problems encountered in implementing RBS and develop their own implementation plan spearhead by Precision Logistics. Once RBS is established as the inventory management model, the Marine Corps will realize sufficient cost savings and increase in weapon systems readiness.

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ABSTRACT

In 1985, the Secretary of Defense directed the services to adopt a weapons management inventory concept that allows readiness and cost to be incorporated into setting inventory levels. The plan is laid out in the Department of Defense's Secondary Item weapon Systems Management Concept. The key to the concept is increasing weapon system readiness at lower costs. Today, this weapons system management concept is known as Readiness Based Sparing (RBS) and has been implemented in all of the services with the exception of the Marine Corps.

The Marine Corps has started to progress toward RBS by chartering studies by the Center for Naval Analysis including a review of RBS requirements and the situation of the present state of logistics systems and data collection. CNA's conclusions suggest a difficult road in implementing RBS due to inaccurate data collection. It is recommended that the Marine Corps examine the Army's implementation process due to weapon system commonality and problems encountered in implementing RBS and develop their own implementation plan spearhead by Precision Logistics. Once RBS is established as the inventory management model, the Marine Corps will realize sufficient cost savings and an increase in weapon systems readiness.

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LIST OF ABBREVIATIONS

AMC	Army Materiel Command
AMDF	Army Master Data File
AMSAA	United States Army Materiel System Analysis Activity
Ao	Operational Availability
AR	Army Regulation
ASL	Authorized Stock List
ATLASS	Asset Tracking Logistics Automated Supply System
BO	Backorder
c	Cost
CAX	Combined Arms Exercise
CEC	Combat Essentiality Codes
CNA	Center for Naval Analysis
DBS	Demand Based Sparing
DI	Due In
DLA	Defense Logistics Agency
DOS	Days of Supply
DRIS	Days Received In Shop
EBO	Expected Backorders
EFR	Expected Fill Rate
EIC	End Item Codes
EMC	Equipment Mission Capable
EOQ	Economic Order Quantity
ERO	Equipment Repair Order
FEDC	Field Exercise Data Collection

FMF	Fleet Marine Force
GAO	GENERAL ACCOUNTING OFFICE
HMMWV	High Mobility Multi-Wheeled Vehicle
I&L	Installations and Logistics
IDN	Item Designator Number
IMA	Intermediate Maintenance Activity
LRT	Logistics Response Time
LRU	Line Replaceable Unit
MARCORSYSCOM	Marine Corps Systems Command
MARES	Marine Corps Automated Readiness Evaluation System
MATCAT	Materiel Category Codes
MCAGCC	Marine Corps Air Ground Combat Center
MCLB	Maine Corps Logistics Base
MCO	Marine Corps Order
MIMMS	Marine Corps Integrated Maintenance Management System
MTBF	Mean Time Between Failure
NMCS	Non-Mission Capable Supply
NSN	National Stock Number
NTC	National Training Center
OH	On Hand
ORD	Operational Requirements Document
OSRAP	Optimal Stock Requirements Analysis Program
OST	Order and Ship Time
PICA	Primary Inventory Control Agency
PR	Probability

RBS	Readiness Based Sparing
RCT	Repair Cycle Time
RO	Requisitioning Objective
ROP	Reorder Point
s	Stock Level
SARSS-O	Standard Army Retail Supply System-Objective
SASSY	Supported Activity Supply System
SESAME	Selective Essential Item Stockage for Availability Method
SL	Safety Level
SORTS	Status of Resources and Training System
TACOM	United States Army Tank-Automotive Command

I. INTRODUCTION

A. BACKGROUND

In 1982, the Assistant Secretary of Defense, Manpower, Juliano published a memorandum stating:

> The traditional approaches to determining inventory levels and measuring supply performance have been related to the satisfaction of demands for items of supply. Such approaches do not normally identify the degree to which various secondary items contribute to the operational availability of weapon systems. We are now attempting to relate stockage decisions to the effect they have on weapon system readiness. This concept represents a significant departure from traditional supply management in that it shifts the materiel manager's concern from item-oriented inventory performance to a weapon system performance.... I cannot over-emphasize the significance of this effort or the magnitude of changes to our materiel management policies and processes that it offers [Ref. 1].

This memorandum led to the 1985 publication of the Secretary of Defense's directive which directed the services to adapt a weapons system inventory management concept that would tie together end items, readiness and cost:

> Improving the material readiness and sustainability of our combat forces is a top priority of the Department. In order to accomplish this, we must develop and implement innovative approaches to inventory management that enables us to focus our attention and resources on the ideas that enhance end item readiness. Weapon systems management is an approach that provides greatly improved material management capabilities. Implementation to this approach will be a long range, incremental effort and will require changes in the area of supply, procurement maintenance, transportation, and financial management. However, implementation of weapon system management will improve material readiness significantly and will

provide the capability to utilize defense resources more effectively. [Ref. 2]

This directive was issued at the same time the General Accounting Office (GAO) was conducting numerous audits on the large size and management of the Department of Defense's inventories.

Since 1985, the Army, Navy and the Air Force have developed inventory models that have incorporated the weapon system management concept. From these models, the concept called Readiness Based Sparing (RBS) came to fruition. RBS models use algorithms that provide recommended inventory levels through the use of the marginal analysis technique, better known as the "best bang for the buck".

The Air Force was the first to develop the new methodology. Tests showed a decrease in backorders of 44% with 46% less investment than inventory models that were previously used [Ref. 3]. The Navy was quick to follow the Air Force's lead and incorporated RBS into their logistics support processes. Presently, the Navy uses RBS methodology on the Arleigh Burke guided missile class of ships and is making progress to incorporate other classes of ships within the next year. The Army's implementation of RBS methodology was demonstrated at various locations within the Nation Guard and the National Training Center at Fort Polk, Louisiana [Ref. 3].

The Marine Corps has been slow in implementing RBS and has not yet been put under GAO's microscope due to the Marine Corps small size of

inventory. In 1990, Marine Corps Order (MCO) 4105.1B was published identifying the need for progression to a weapon system management structure. The management structure would incorporate the 13 capabilities that were outlined in the 1985 Secretary of Defense's directive on weapon systems management. The 13 capabilities include:

(1) Application files

(2) Stock levels for weapon system using a availability based sparing inventory model

(3) Multi-echelon optimization models

(4) Integrated initial/replenishment

(5) Asset visibility

(6) Demand/usage reporting

(7) Inter-service data exchange

(8) Performance tracking

(9) Asset positioning

(10) Redistribution

(11) Development of planning

(12) Programming and budgeting system

(13) Budget execution and balancing resources

MCO 4105.1B goes even as far as to delegate responsibilities for the weapons system management concept to various commands throughout the Marine Corps [Ref. 4].

Little progress has been made in developing an implementation plan for RBS, and weapon systems management is still idle. In the last two years, the Marine Corps has showed a renewed interest in migrating to RBS and has chartered the Center for Naval Analysis (CNA) to perform multiple studies. The studies investigate the requirements that are needed to migrate to a weapon system inventory management concept through the use of RBS and the state of data collection at the present time. Throughout the chartered studies and interviews made by the author, CNA has continually suggested to analyze the Army's implementation of RBS due to the commonality of weapon systems and sources of supply support in order to develop an RBS implementation plan for the Marine Corps.

B. RESEARCH QUESTIONS

This research will address and answer the following questions:

1. Primary Research Question

How can RBS be successfully implemented into the Marine Corps?

2. Secondary Research Questions

- What is RBS and how does it differ from the present system?
- How has the Army implemented RBS? What were their past and present problems?

- What are the anticipated problems for implementing RBS in the Marine Corps? Are there common themes with the Army?
- What types of barriers will the Marine Corps likely encounter in implementing RBS? How can they be overcome?

C. PURPOSE AND METHODOLGY

Progress to incorporate an RBS methodology has been slow. In order to get the Marine Corps in compliance with the 1985 Department of Defense directive, it is important to investigate the Army's implementation of RBS and analyze their progress and shortcomings. Along with analyzing the Army's implementation of RBS, it is also necessary to review the findings of CNA as regards the present state of Marine Corps data collection and to determine if common problems exist between the Army and the Marine Corps. Finally, an implementation plan for implementing RBS within the Marine Corps needs to be developed to provide a path for the migration to RBS.

D. SCOPE, LIMITATIONS AND ASSUMPTIONS

This study is limited to analyzing the studies and interviews by the United States Army's Army Materiel Systems Analysis Activity (AMSAA) and the CNA and their application to Marine Corps weapon systems.

E. STRUCTURE OF THESIS

This thesis is divided into six chapters. Chapter I presented the problem, stated the purpose, and described the scope of the research effort and associated research questions. Chapter II describes the item and system approaches and the

methodology of RBS. Chapter III analyzes the Army's problems in implementing RBS and the various workarounds that they have developed. Chapter IV analyzes the Marine Corps problems CNA has identified in implementing RBS. Chapter V develops a plan for the Marine Corps to implement RBS.

II. INVENTORY MANAGEMENT

This chapter compares and contrasts demand based sparing (DBS) and readiness based sparing (RBS) methodologies. It is important to understand the limitations of the present demand based sparing compared to the ability of readiness based sparing to provide inventory in support of readiness goals.

A. DEMAND BASED SPARING (DBS)

Demand based sparing methodology has played a major role in the Department of Defense's inventory management for decades. It has been characterized as a days of supply (DOS) and an item approach to inventory management. In the item approach, stockage level decisions or, as referred to throughout this thesis, a requirements determination to stock a given spare is made independently of decisions made to stock other spares. Spares, as defined throughout the thesis, are held replacements for like components on a weapon system that can be repaired or disposed of when they fail.

The requirements determination uses the following criteria: safety levels (SL), order and ship time (OST), and repair cycle times (RCT) of reparables.

Safety Levels (SL) are additional spares held on hand to support contingencies and fluctuations in demand. Most of the time the same protection level will be applied across all items. A protection level is a designated percentage of spares that are on hand.

Order and ship time (OST) is the time it takes between requisitioning of the spare and the time the requisitioning unit receives the spare.

Repair cycle time (RCT) is the time required to repair the inoperable item to an operational status.

In the Marine Corps, historical demand is captured and translated into demand per day. MCO 4400.151 establishes the DOS methodolgy to include a 60-day operating level, 30-day safety stock, an actual order OST level, and RCT for repairables.

Once an item has been selected for stock, its depth must be determined. One of the principal tools for managing the depth of stock is the requisitioning objective/reorder point (RO/ROP). RO/ROP is principally derived from operating level (OL), SL, and OST authorizations. Specifically, RO is the sum of the OL, SL, and OST level. The ROP is the sum of the SL and OST level. The RO and ROP serve to systematically advise the inventory manager when to purchase stock and how much to purchase. Stock is ordered when the ROP is reached, and is ordered up to the level of RO [Ref. 4].

One appropriate use of demand based sparing methodology is for non-critical consumable spares. An example of a non-critical spare would be a indicator bulb. The non-availability of this item would not render a weapon system inoperable. As will be shown throughout this thesis, demand based sparing algorithms would still be required even when RBS is used.

There are many disadvantages to DBS, which is currently employed in the military and the Defense logistics Agency (DLA). First, DBS is considered to be an item approach to inventory because it treats all items equally. A consumable item that would not render a vehicle inoperable, a headlight for example, is treated equally as an item that would render the vehicle inoperable. The headlight would be considered a safety issue; this would not deter the vehicle from being driven in a combat situation. An alternator would be an example of an item that would render a vehicle completely inoperable.

Second, these items are not associated with a particular weapon system like a five-ton truck. Today, in an environment of dwindling budgets and military readiness on top of every congressman's agenda, making sure that highly visible weapon systems, such as the M1A1 tank, maintain a high degree of readiness is a must. The failure of not associating prospective spares with systems not only degrades the operational availability of the system, but decreases readiness. Most general officers would much rather accept a High Mobility Multi-Wheeled Vehicle (HMMWV) inoperable compared to a weapon system, such as a tank.

By using the item approach, inventory managers do not have the benefit of decision support tools to make analytical, cost-readiness tradeoffs. For example, let's assume the total number of spares required that are generated by the demand-based sparing model dictates a stockage of $300,000 in parts. However, the budget provides for only $100,000 for spares, and the inventory manager has no analytical

method for prioritizing the available investment; therefore, he/she is left to determine adjustments based solely on experience and subjective decision making techniques. Additionally, even if the inventory manager had the $300,000 to invest, the demand-based sparing model does not relate inventory investment to the readiness of the equipment being supported. Consequently, the inventory manager could purchase all the parts recommended by the demand-based sparing model only to discover that critical weapons systems still did not meet their readiness objectives [Ref. 4].

Inventory mangers do use a form of the Economic Order Quantity (EOQ) model for requirement's determination, a model that minimizes inventory ordering and carrying costs. However, there are many drawbacks to the use of this model in the military. First, demand is constant and known in this model. In the military demand is fuzzy, meaning that it is unpredictable rather than constant. Secondly, the model assumes that receipt of inventory is instantaneous. In this context, instantaneous means that once an order is placed for a spare, the order arrives the same day. This assumption is inaccurate due to the tremendous number of backorders, which affect weapon system availability.

B. READINESS BASED SPARING (RBS)

Readiness based sparing is a system approach whose goal is to maximize the operational availability of a weapon system within management imposed budgetary constraints. Operational availability (A_o) is the percentage of time that

a system is capable of performing its intended function. The focus is on the entire weapon system, and questions such as how much will it cost to obtain a spares in order to attain availability of 90% for a particular weapon system and how much would it cost to achieve a 95% spare availability are asked.

There are complexities related to each weapon system. Compare two spares that can deadline the same weapon system. One spare may cost $100.00 while the other costs $1,000.00. Since both spares can independently deadline the weapon system, it is reasonable to assume that they both have identical impacts on operational availability. However, since the spares have different impacts on the budget, it is not reasonable to assume that it is optimal to stock the same amount of each of these parts. Analyzing the costs of both spares and the similar impacts on operational availability, more "bang for the buck" is received in stocking an abundance of the least expensive part. It is also important to keep in mind that spares that have twice the demand rate will have greater impact on operational performance regardless of cost. Readiness based sparing determines the marginal increase in operational performance per increase in unit spares cost. In this manner, the most cost-effective spares can be added until the operational performance requirement is adequately supported.

For RBS, comparisons are made between spares in the categories of demand, price, OST, RCT and criticality. Spares are selected to meet the availability goal for the system. Therefore, there is no set demand threshold that a repair part must meet to be eligible for stocking. The combination of demand and

price can be used to determine the order in which spares are selected, and the availability goal determines the total number of spares selected.

A weapon system availability-cost curve as shown in Figure 1 is helpful in answering the questions of how much would it cost to attain a specific availability or a higher one. The curve represents the dollar cost given incremental changes in spares availability. Points that are located above and below the curve represent inefficiencies. The law of diminishing returns is reflective in the curve also. At successive levels of readiness with the increase in spares availability, the cost of the additional availability also increases. This curve gives the inventory manager the ability to see the difference in costs in relation to each level of spares availability and how much availability can be attained within the budget constraints.

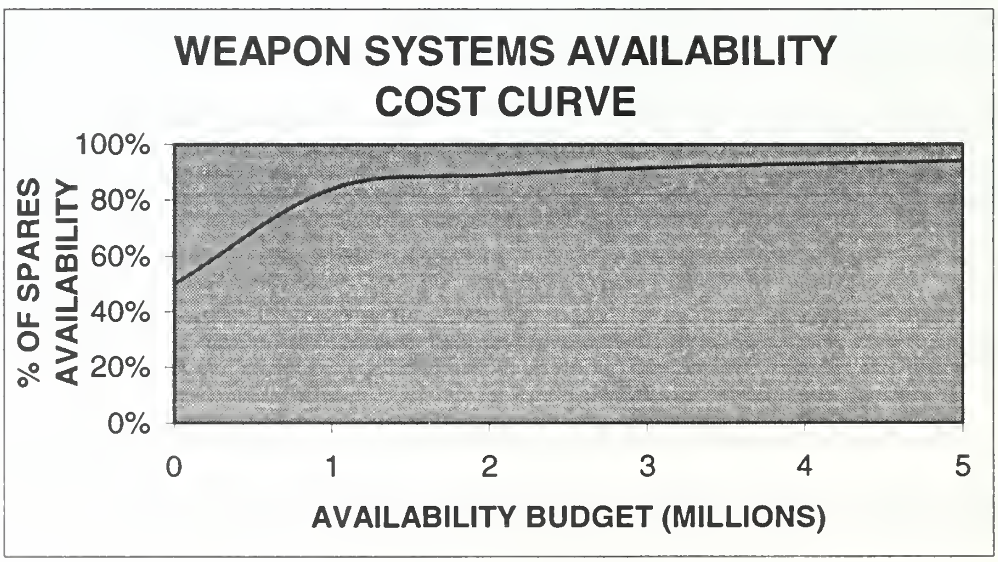

Figure 1. Weapons Systems Availability Cost Curve

C. MODEL DESCRIPTION

1. Background

The Marine Corps' maintenance strategy, like the Army's, distinguishes between two different types of spares: Line Replaceable Unit (LRU) and a consumable LRU. An LRU is a mission essential reparable such an alternator or a circuit card. When an LRU is removed due to inoperability, it creates a "hole" in the weapon system [Ref. 5]. The inoperable LRU is then turned into an immediate maintenance activity (IMA) for repair. In exchange for the inoperable LRU, an operable LRU is provided to fill the "hole" which was created by the removal of the inoperable LRU. Once the replacement is complete, the weapon system is restored to its original operating condition. If the LRU is not in stock, which often occurs in the military, it will be placed on backorder only if funding is available. The weapon system would then be on a non-availability status. If funding is not available, the required LRU(s) are placed on a short funds priority list. Once money is available, the LRU(s) would be placed on a backorder status. A consumable LRU, such as a diode, is a mission essential repair part that is removed from either a failed LRU or another failed consumable LRU [Ref. 6].

An important characteristic of an LRU is that it is *memoryless*. It is classified as such because the time to the next failure is not dependent on the time of the previous failure. Since the LRU is independent and random from the last failure, it follows an exponential distribution, also known as a Poisson process.

The Poisson process is also used for low demanded items because the mean time between failures (MTBF) is unpredictable. When using the exponential distribution, the number of demands or failures over any fixed time period is given by the Poisson Distribution.

2. Indentured Structure

For a want of a nail, a shoe was lost.
For want of a shoe, a horse was lost.
For want of a horse, a rider was lost.
For want of a rider, the battle was lost

RBS accounts for the relationship between LRU(s) and consumable LRU(s) when making stocking decisions using an indenture structure. An indenture structure provides a hierarchy of parts in a manner similar to the way a typical organization chart depicts a hierarchy of departments and units in an organization. Lower indenture spares, such as gaskets and spark plugs, are common items that can be used in several different assemblies and on items higher up the indenture hierarchy. Clearly, a lower indenture part costs less than its parent. Due to its low cost, there are incentives to stock lower indenture parts rather than their higher-indenture parents. Conversely, when an item fails, it takes more time and expertise to diagnose and replace the lower indenture items responsible for the failure than whole assemblies or parent items. This extra time translates into longer system downtime. This longer downtime establishes a compelling incentive for the inventory manager to stock higher-indenture and high cost spares. RBS balances these competing objectives and assists the inventory manager in

making stocking decisions [Ref. 4]. Figure 2 illustrates a breakdown/indentured structure of a weapon system into LRUs and consumable LRUs.

Indentured Structure

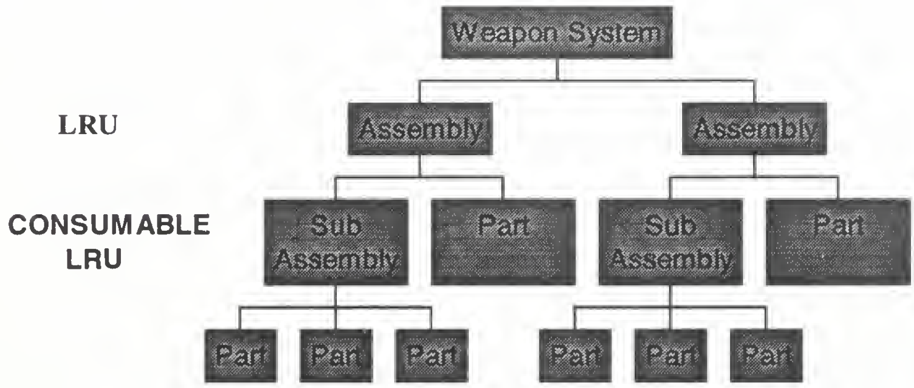

Figure 2. Breakdown of weapon system into LRU and consumable LRU

3. The Single Site Model

The single site model is fundamental to the analysis of the RBS methodology because it models the distribution of failures with the Poisson Process. Even though this model is not realistic for military purposes, it is important in describing the basic methodology of RBS.

The single site model looks at the spares selection only at a single base and disregards spares determinations made at other bases and depots. The base is regarded as the retail IMA level of the supply/maintenance structure, and the depots are regarded as the wholesale supply/depot maintenance.

This model maximizes weapon system availability by minimizing the expected backorders (EBO) which increase the fill rate at a specific base. The EBOs are the expected number of unfilled demands that exist at a point in time. The fill rate is the percentage of demands that can be met at the time they are placed. To minimize the EBO, the model uses a technique called marginal analysis, also known as the "best bang for the buck" algorithm to achieve its goals by efficiently optimizing the budget and/or by attaining an expected fill rate [Ref. 5]. Each step of the marginal analysis algorithm, takes a heuristic approach and identifies the delta (Δ) for each item to determine the next item to buy from a list of spares candidates. This process is continued until the optimization goal is realized. Below is the marginal analysis algorithm:

Stock level (s) is defined as

$$s = \text{OH} + \text{DI} - \text{BO}$$

where OH is the on hand inventory, DI is the quantity due in, and BO is the number of backorders. Then the expected fill rate (EFR) is

$$\text{EFR}(s) = \Pr\{\text{DI} \leq s\text{-}1\}$$

For expected backorders compute the probability that the number of items due in exceeds the stock level s, or

$$EBO = \sum_{x=s=1}^{\infty}(x-s)\Pr\{DI = x\}$$

For each item (at stock level s=0) with the cost (c), compute the quantity (marginal analysis technique)[Ref. 7]

$$\frac{EBO(s) - EBO(s+1)}{C}$$

This formula shows the marginal decrease in expected backorders per unit cost obtained by adding one unit of a particular item. An example of the use of the marginal analysis technique is shown below.

In Table 2.1, the two items are shown with mean or average annual demand, the average repair time (days), the average pipeline (the number of units of the item in repair), and the item cost [Ref. 5]. In Table 2.2, the Δ is the marginal decrease in the EBO (marginal increase in operational availability) per unit cost by adding one additional unit of stock. The Poisson distribution calculates the EBO values [Ref. 5].

Table 2.1. Two Items Compared

	ITEMS	
	1	**2**
Mean annual demand	10	50
Average repair time	0.1	0.8
Average pipeline	1	4
Item cost($000)	5	1

Table 2.2. Marginal Analysis Technique

	ITEM 1		ITEM 2	
s	EBO(s)	Δ	EBO(s)	Δ
0	1.000		4.000	
1	0.368	.126	3.018	0.982
2	0.104	.053	2.110	0.908
3	0.023	.016	1.348	0.762
4	0.004	.004	0.782	0.567
5	0.001		0.410	0.371
6	0.000		0.195	0.215
7	0.000		0.085	0.111
8	0.000		0.034	0.051
9	0.000		0.012	0.021

Notice that before stocking any items, the expected backorders are 1.000 and 4.000 and that the total 5.000 is equal to the total amount in the pipeline and is the expected demand. The first Δ's for the two items are 0.126 [(1.00 - .368)/5] and 0.982 [(4.00 – 3.018)/1]. In comparison we would get more "bang for the buck" if we add another item 2. Next compare 0.126 and 0.908, and add another unit to item 2, and so on until the comparison is between 0.126 and 0.111. At this time the first unit of item 1 is added. This process is continued until the optimization goal is achieved [Ref. 7].

4. Multi-Echelon Problem

The single site model explains the very basic concepts of the readiness based sparing model. However, there are several reasons why a multi-echelon model is needed. First, a multi-echelon model depicts how the military actually operates in its complex supply/maintenance environment. Secondly, decisions must be made throughout the entire supply system on the optimal spares to have on hand to satisfy EBOs that are generated by demand. Using the single site model for all bases would sub-optimize the total system because it would be ignoring like decisions at other bases. A decision to carry a specific spare at the base should depend upon what is carried at the depot. If the item were carried at the depot, the bases would be disinclined to stock it. If the spare were not carried at the depot, there would be an incentive to carry the spare at the base level. Thus, interactions between bases and depots need to be taken into account [Ref. 7].

There are many factors that contribute to the time required to re-supply a LRU to a base: demand rate, the maintenance concept that consists of the levels of repair, RCT, SL, OST, and the pipeline. Repair times and quantities on hand and in repair vary from depot to depot.

The time required resupplying a consumable LRU to a base is under the same constraints as the LRU with the exception of repair cycle times. Putting a spare at the depot will affect the resupply times ranging from days to weeks at a base. Furthermore, base spares' levels and resupply times impact the time a

weapon system will be inoperable due to delays in filling a non-mission capable supply (NMCS) requisition at the base level.

The multi-echelon RBS model makes decisions on where and how much to stock LRUs and consumable, and it optimizes the total system by accounting for the attributes at each activity at each echelon [Ref. 7]. To find cost effective stockage decisions, it is necessary to not only distribute a fixed number of spares throughout the entire system but also to know the optimal number of spares to distribute and the logistics delay time for each type of spare.

D. DATA REQUIREMENTS FOR DBS AND RBS

In Table 2.3, a side by side comparison of DBS and RBS data requirements is provided. The data required for the RBS model versus the DBS model provides the impetus for the required weapon systems inventory management as mandated by the Department of Defense.

Table 2.3. RBS- and DBS Data Requirements (Ref 4)

	DBS	RBS
TARGET DATA		
Ao Goal		*
Budget Goal		*
Weight/Cube Goal		*
Fill Rate Goal		*
WEAPON SYSTEM DATA		
Indenture Structure		□
End-item Criticality		*
End-item Usage		□
End-item Density		*
Reliability Block Diagram		□
SPARES DATA		
NSN/Nomenclature	*	*
Cost	*	*
Weight/Cube		□
Source Maintenance Recoverability Code	*	*
Combat Essentiality Code	*	*
End-item Application		*
FAILURE RATE DATA		
Demand	*	*
Operational Failure Rate/MTBF		□
PIPELINE DATA		
Order Ship Time	*	*
Repair Rate	*	*
Washout Rate	*	*
Repair Cycle Time	*	*
DEPLOYMENT DATA		
Environment		
Climate		
Intensity Rate		

***=REQUIRED** **□=OPTIONAL**

E. SUMMARY

The readiness based sparing inventory model, unlike demand based sparing, is a concept for requirement's determination that associates spares to individual weapon systems in order to sustain a specified operational availability. RBS responds to the changing needs, priorities, and management-imposed constraints of a weapon system in the most cost-effective manner to ensure the readiness of the system is not degraded. As mentioned in Chapter I, the Department of Defense has mandated the progression to readiness based sparing methodology to sustain a high readiness posture.

Progressing to RBS is a complete paradigm shift from the DBS inventory model. This chapter provided a foundation that will be needed in understanding the problems that the Army is having and the future problems Marine Corps will have in transitioning to RBS and developing an implementation plan.

III. UNITED STATES ARMY'S RBS MODEL AND ISSUES

Moving from the item approach to the systems approach in inventory management has been a complete paradigm shift for the Army. In this Chapter, the discussion will explore the variety of "workarounds" the Army has incorporated to bypass past and present inaccurate data collection, the field demonstrations conducted to support RBS, and the cultural problems that presently exist in accepting RBS.

A. SYSTEMS APPROACH

As identified in Chapter II, when using an RBS model, there is a necessity in the systems approach to identify all parts that are associated with weapon systems. These associations create an indentured structure of the weapon system. The indentured structure establishes a tree-like breakdown, which classifies how all the parts are interrelated within the weapon system. Developing the parts association has become a cumbersome task for the Army. One way that the Army has tried to tackle this task is by the use of end item codes and materiel category codes.

1. End Item Codes (EIC)

To run any RBS model effectively, as compared to the present Army and Marine Corps DBS stockage computations, parts must be associated with end items. It is conceivable that failed LRUs can belong to different end items. Unless time is taken to identify the parts' end item association, demand data for

the weapon system will be inaccurate. If parts are not identified accurately, Army personnel at the retail level would have to decide which vehicle the part belonged to. This decision would affect the RBS model during the requirements determination for the authorized stock list (ASL). An ASL is allowance of stocks that are authorized to be on hand.

End item codes (EIC) are three digit codes that identify a specific weapon system. The first position of the EIC depicts a broad category of items and the item manager that is responsible for that category for example, the U.S Army Tank-Automotive Command (TACOM). The second position further identifies the items in relation to a broad generic group of end items such as the M1 Main battle tank. The third position identifies the specific tank, M1A1 [Ref. 8]. The use of EICs attempts to solve the problem of associating parts with end items and to develop a single level of indentured structure.

Presently, the problem is that EICs are not available for most of the national stock numbers (NSN) demanded. The Army is slowly providing EICs for all NSN. It is estimated that this process will take several more years.

2. Materiel Category Codes (MATCAT)

To overcome the lack of end item codes, the Army transitioned to the use of materiel category codes, which are present for each NSN in the Army Master Data File (AMDF). The AMDF consists of the national stock number listed in the demand file, preferred national stock number, nomenclature, materiel code,

essentiality code, supply material category code, unit price, maintenance repair code, weight, and cube [Ref. 9].

The MATCAT is a five position alphanumeric code that identifies the material category structure. For the purpose of RBS, only the last two positions are used [Ref. 10]. The MATCAT identifies the end item but lacks the specificity of the EIC. The specificity is not required because all weapon systems are broken down into twelve weapon system groups. The weapon system groups consists of aircraft, combat, communications, DLA, electronics, generators, weapons, M1, M113, missile, tactical and high demands [Ref. 9]. When the Army runs the RBS model, if any of the weapon system groups contain less than 100 NSNs, that weapon system group is combined with another group. This is to ensure that one or two national stock numbers do not dominate the authorized stock list (ASL). A RBS system can run all the groups at one time, but due to processing time, which can take a couple of minutes to a couple of hours depending on the number of NSNs, the Army limits the RBS model to one group at a time.

B. INFORMATION COLLECTION

1. Demand

A major problem with demand is variability. It is difficult to estimate on a daily basis that there will be, for example, ten demands for a specific spare in a given year. An estimation of an average demand is possible, but this average must also include a forecasting error. If the division typically has 300 tanks and each

tank is rendered inoperable every 15 days, and there are 2,000 parts on the tank, not every part fails annually. This leads to the difficulty in forecasting specific spare demand when no data exists for specific parts over a period of time. For example, a certain NSN may not fail for a couple of years, thus demand would not be present.

The Army bases its peacetime retail stocks of spares on rules that are established by Army Regulation (AR) 710-2, "Inventory Management Policy Below the Wholesale Level" [Ref. 11]. This regulation provides policy and implementation guidance for stockage determination and the replenishment processes in retail inventory management. For stocks to be qualified candidates to be incorporated in the ASL, they must qualify by add/retain criteria. Add/retain criteria establish that parts must have 9 demands within 360 days to be viable candidates for listing on a unit's ASL.

The add/retain criteria may seem like an efficient way to manage inventories, but it has some significant drawbacks. For example, an army division ASL may have approximately 12,000 items stocked. When the ASL is yearly updated approximately 2,000 to 3,000 line items drop off due to not qualifying within the criteria to be stocked at the division ASL. When the Army attempted to update the ASL on a five-year basis, again there was a significant number of items that dropped off due to lack of sufficient demand history.

A 1996 study by the Army Material Systems Analysis Activity (AMSAA) attempted to show the shortfalls of the add/retain criteria at the 3rd Infantry Division. AMSSA identified that 79 percent of the mission essential stocks that were demanded had fewer than the nine required demands and thus would not have qualified to be on the ASL in accordance with AR710-2. Specifically, 51 percent of the stocks demanded had fewer than three demands (Ref. 12).

There are two striking shortcomings resulting from using the add/retain criteria. First, readiness is reduced. As shown in the 3rd Infantry Division study, 79 percent of the customer's demands were not filled due to the stocking criteria. This translates to a decrease in weapon systems readiness. Concurrently, the weapon systems readiness will remain low until the spare is received from the next source of supply. This time frame can range from three days to more than 30 days.

Secondly, incentives for "gaming" are created by individual unit commanders so that mission essential parts qualify as candidates for the ASL. Units begin to artificially reduce the quantity demanded on one requisition to submit multiple requisitions. Another alternative is to submit requisitions for stocks that the unit does not require at the time but does so to artificially increase the number of demands.

2. Mean Time Between Failure (MTBF)

The incentives to manipulate demand contribute, to a large extent, to the inaccurate demand data that the Army now has to contend with. One way to combat this problem is to find the MTBF for mission essential parts.

MTBF measures how often the weapon system is inoperable due to a specific corrective action. Presently, the Army RBS model does not include MTBF. This lack of MTBF data within the model impedes the Army in calculating systems failures [Ref. 13]. There is a move by AMSAA to gather MTBF data for LRUs. This is a time demanding process, but when the MTBF for first line indentured LRUs are identified then AMSAA will be able to provide more concise spares calculations.

AMSAA's first major step in calculating MTBFs for the entire weapon system was to gather all functional and technical experts throughout the Army from all the major weapon systems programs to provide fleet wide averages for weapon systems. Due to the inaccurate demand data, these averages were based on the incidence of any type of failure for the entire weapon system.

The Army established the following MTBF averages for the indicated weapon systems. Days refer to incidence of any type of failure: track vehicle's MTBF is fifteen days, wheeled vehicles are thirty days, and electronic end items sixty days [Ref. 13].

3. NSN Changes

Another issue that the Army identified that can cause a problem to an RBS model is changes in national stock numbers. When modifications are made to an LRU, a change in the national stock number will reflect those modifications. The problem is amplified when all the national stock numbers for the same LRU, modified and non-modified, are resident in the retail and wholesale mainframes, resulting in all national stock numbers becoming suitable replacements for the same LRU. Since all the national stock numbers from the LRU are resident at both levels, units will requisition the different national stock numbers. Thus, the RBS models will recommend stocking the multiple national stock numbers of the same LRU. To correct this problem, guidance must be provided at the item manager level, identifying which LRU national stock number is the prime, and thus not requisitioning the others. Correction of this problem is ongoing [Ref. 13]. To alleviate this problem, representatives from the Department of Defense and outside agencies must be involved.

C. ARMY MODELS

AMSAA developed two RBS models for developing stockage requirements: the Selective Essential Item Stockage for Availability Method (SESAME) and the Optimal Stock Requirements Analysis Program (OSRAP).

SESAME is a four echelon, two level of indenture, inventory model. It determines optimal stock lists in a multi-echelon system and evaluates alternative

stock lists for the supply/maintenance system. This model has been used at the wholesale level for the Army's initial spares budgeting and procurement for more than a decade [Ref. 5].

After seeing favorable results in using SESAME, the Army Materiel Command (AMC) directed the use of this model in all initial wholesale provisioning decisions. In a directive dated 16 April 1990, General Tuttle, AMC, stated RBS provided the Army with an opportunity to support readiness of weapon systems at the least cost and that the benefits to be gained should not be delayed [Ref. 3].

Unfortunately, this fanfare was short-lived. After the initial provisioning of two years was completed, the retail level reverted the stockage requirements back to the present AR710-2 computations. The only explanation for the reverting back to the AR710-2 computation is retail level supply's reluctance in accepting RBS methodology.

OSRAP is a coordinated multi-echelon model that determines optimal levels and reorder points for class IX (repair parts). Its goal is to produce an optimal cost solution while meeting desired performance goals. OSRAP had been used in computing stockage requirements for operational contingencies in Operation Desert Shield/Storm, Somalia, Bosnia, and Haiti [Ref. 14]. A personal computer-based version of OSRAP has been developed for material managers at

all supply levels. However, it is a stand-alone system and is not embedded within the retail supply system architecture [Ref. 3, 13, 14]. This lack of integration is a factor why the Army has not adopted RBS.

D. RBS FIELD DEMONSTRATIONS

The objective of the RBS field demonstrations was to determine if this methodology provided cost savings while maintaining readiness and improving supply performance for field units compared to ASLs computed using AR710-2 stockage computations and management discretion. The first field demonstration was located at the National Training Center (NTC) in 1992, followed by quantitative studies located at the 3rd Infantry Division and the 25th Infantry Division in 1996.

1. National Training Center (NTC)

This demonstration's objective was to identify cost savings while maintaining the same level of readiness and to determine if there was an increase in supply performance such as fill rates [Ref. 9].

a. Cost Savings

In the NTC demonstrations, net costs were significantly less than ASL prior to the demonstration. The cost of the ASL was reduced from $126.7 million to $68.7 million. Net assets (on hand + due in – due out) were reduced by $37 million [Ref. 9].

b. Equipment Readiness

Equipment readiness indicators increased from 66 to 82 percent with RBS [Ref. 9]. The readiness indicators consisted of Equipment Mission Capable (EMC) and Non-Mission Capable Supply (NMCS).

c. Supply Performance

In all measures of supply performance, RBS outperformed ASL as shown below in Table 3.1.

Table 3.1. NTC Field Demonstration Supply Performance Results [Ref. 9]

MEASURE	**ASL**	**RBS ASL**
Demand Accommodation	64 percent	81 percent
Demand Satisfaction	70 percent	88 percent
Fill Rate	45 percent	71 percent
High Priority Fill Rate	48 percent	72 percent

The most striking figure that is exhibited in this table is the 26% increase in the fill rate in RBS over ASL. This shows that parts that are essential to readiness were readily available to the unit. This translates to fewer demands being forwarded to another level of supply support, the wholesale level, for parts that were causing a weapon system to be inoperable.

2. 3rd Infantry Division

This study used demand history from January to December 1996. The study included a cost distribution of demand, and compared the supply performance of RBS, actual ASL, and an ASL recommended by the Standard Army Retail Supply System-Objective (SARSS-O). The SARSS-O is a retail level supply system and uses AR710-2 computation in developing stockage requirements.

Table 3.2. 3rd Infantry Division Supply Performance [Ref. 12]

MEASURE	SARSS-O ASL	ACTUAL ASL	RBS
Size	5,604 Lines	5,424 Lines	11,612 Lines
Value	$28.6 Million	$80.3 Million	$34.3 Million
Demand Accommodation	79 percent	68 percent	86 percent
Demand Satisfaction	75 percent	80 percent	94 percent
Fill Rate	59 percent	54 percent	80 percent

Of the 38,364 NMCS demands, 71 percent of the requisitions were less than $100.00 each [Ref. 9]. The RBS ASL was 22 percent more costly than the SARSS-O, which can be attributed to the additional lines carried. However, in supply performance, the RBS ASL outperformed both ASLs. In this case, similar to the demonstration at NTC, requisitions were filled at the unit level vice being passed on to the wholesale level. Again, this translates to an increase in readiness

for weapon systems. The increase in the fill rate of 21-26% is a definitive reason that shows the need for RBS.

3. 25th Infantry Division

In this study the demand history was accumulated from April 1996 to September 1996, and RBS ASL was compared only to the actual ASL. As found in the previous studies, the RBS ASL out-performed and was $ 2.7 million less than the actual ASL.

Table 3.3. 25th Infantry Division Performance [Ref. 12]

MEASURE	ACTUAL ASL	RBS ASL
Size	3,019 Lines	5,165 Lines
Value	$8.4 Million	$5.7 Million
Demand Accommodation	64 percent	80 percent
Demand Satisfaction	72 percent	85 percent
Fill Rate	46 percent	68 percent

As depicted in Table 3.3, the RBS ASL had a greater number of lines, but the total cost of the inventory was $ 2.7 million lower, demand accommodation and satisfaction increased by16% and 13%, and the fill rate increase by 14%. This study provides another example of how the marginal analysis technique provides the "best bang for the buck".

E. ANALYSIS OF FIELD DEMONSTRATIONS

In reviewing the three studies, the RBS ASL consistently demonstrated that this model outperforms the actual ASLs that follow the AR 710-2. On average, RBS ASL outperformed actual ASL by 20 percent in demand accommodation, 21 percent in demand satisfaction and 17 percent in fill rate. These demonstrations indicate that an ASL developed using the RBS methodology could reduce the amount of investment required, and in some cases, improve the current level of readiness and supply performance that is now being achieved using AR710-2 ASL computations.

F. THE WAR RESERVE REQUIREMENT

1. Data Collection

In the wartime environment there are numerous challenges that affect all aspects of military operations. The greatest challenge for the logistician is in providing the required support to sustain a combat force. This support must be present within the operations area or be available from the combat service support area. An operational commander cannot have a major weapon system be inoperable before a major engagement due to a spare not being available in a spares block.

Field Exercise Data Collection (FEDC) is an effort established by AMSSA to answer this challenge. FEDC is a data collection effort that collects part replacement rates for combat required mission essential end items from wartime

training exercises. The information collected through FEDC will be used for the wartime reserve RBS calculations. In the past, the Army relied on peacetime demand requirements to satisfy its wartime requirements. To satisfy the expected increase in demand and develop stockage requirements during actual combat operations, a multiplier is used to determine peacetime demand rates.

Another means of collecting data was performed on individual end items during normal peacetime usage and field training exercises over a specified period of time [Ref. 15]. The Army Materiel Command's major subordinate commands' field training exercises consisted of two to three weeks of simulated combat. This combat environment enabled AMSAA to collect parts replacement rates, petroleum and lubricants data, and manpower requirements from battalion sized units.

FEDC began in September 1982 with exercises conducted in Germany. Since these initial exercises, it has expanded to NTC at Fort Irwin California, Korea, Kuwait, and the Joint Readiness Training Center at Fort Polk. Since its inception in 1982, data from more than 200 mission essential end items that participated in more than 500 exercises have been put into the FEDC database [Ref. 15]. With the use of this database, AMSAA is now able to extract information on LRU failure rates for calculating the MTBF rates.

Data collection during the FEDC is comprised of three phases. The first phase consists of briefing the soldiers who are involved in the exercise. The brief

explains the rationale for the data collection and how the data collection can provide the necessary information to support combat forces. All mission essential end items that are involved in the exercises are inventoried, the individual maintenance records are reviewed, and a limited technical inspection of the end items is completed. The limited technical inspection consists of operational and safety inspections. The second data collection phase begins with the start of the exercise and proceeds with collection of data from failed LRUs and consumable LRUs. At this point, vehicles that are inoperable are documented with the repairs required, mean time to repair figures, and manpower dedicated in the repair process demands. The final phase involves a final technical inspection of the end items and the repair and documentation of any failed LRU or consumable LRUs.

Annually, a summary of each of the sites is produced and distributed to all major Army commands. The summary includes end item profiles, man-hour requirements, parts usage profiles, and exercise parts usage planning factors for each site [Ref. 15].

2. RBS Demonstrations

To promote the OSRAP RBS model for war reserve requirements, AMSSA made a stockage determination comparison between OSRAP using RBS methodology and the Status of Resources and Training System (SORTS) using the AR710-2 days of supply computation. The objective was to identify which model provided stockage requirements in relation to cost and readiness for the weapon

systems. The demonstration showed that OSRAP provided a larger breadth of spares, achieved the readiness goals, and also afforded a 20 percent reduction in overall total cost.

In an interesting twist of fate, AMSAA discovered that the preliminary run of OSRAP saved more money than was expected. After revalidating the dollar value, there was uneasiness on AMSAA's part to release the dollar figure. If AMSAA provided the dollar value to the Army, the Army would not believe the dollar value, causing the Army to doubt the credibility of the model.

The significant savings occur for the following reasons. The review of RBS in Chapter II described how use of the marginal analysis technique provided an ASL with the "best bang for the buck". Consequently, the model selected the items that were low cost, high demand, and frequently backordered. The dollar value dropped dramatically because the engines were dropped off the ASL. Because the unit costs are very high and demand for an entire engine low, the ASL recommended a small number to be on hand. Due to the low total cost, resulting in the perception of model unreliability, AMSAA decided to add additional M1A1 engines back into the model, using the justification of stocking more engines at the retail level. The dollar figure was provided that each engine cost approximately $500,000 and the total dollar value of the engines was 25% of the wartime reserve budget [Ref. 13].

In analyzing the field demonstration, AMSSA deliberately decreased some of the savings due to the uneasy feeling of saving the Army too much money and stocking a small amount of engines. To support the end result, AMSSA gave the war reserve officers the actual stockage lists, after adding the engines, for the lines that they supported and the results of the RBS model to the Army. The Army compared the data and realized that readiness did increase and the depth of the high dollar items decreased. The data was acceptable to the Army.

G. ORGANIZATIONAL AND TECHNICAL BARRIERS

The use of RBS methodology is not new. As discussed in Chapter I, the Department of Defense and the Army have been developing models and the methodology since the late 1980s. As already stated, field demonstrations at various Army sites have proven that readiness based sparing is effective in retail applications. Throughout the demonstrations, RBS has provided better outcomes for supply performance parameters such as stockage levels, fill rate and zero backorders. Universally, the RBS provides more stock for less cost and has a higher fill rate percentage. Yet, to this day, AMSAA has not had the army officially approve the standard use of RBS. RBS has been recognized in the current update of the AR710-2 only as an optional method of stockage determination.

Why has RBS not been accepted as the standard? This lack of acceptance suggests that there is resistance to change.

H. RESISTANCE TO CHANGE

During an interview with AMSAA officials in Aberdeen, MD, the question was asked why apprehension exists in the acceptance of RBS. AMSAA identified two main reasons. The first is mistrust in the stockage selection. As the field demonstrations have continuously shown, the breadth of inventory lines had increased. This increase was balanced out with the decrease in high dollar, high visibility items.

The active duty Army, even though it is going through a period of austere budgets, continues to want to stock high cost items. For example, the Army still desires to stock a large percent of M1A1 engines, with a unit cost of $500,000, when the RBS model identified the need for carrying a smaller percent of engines. This problem is explained by the cultural mentality that "more is better" which is common to all services and is the chief barrier to RBS implementation. When the "more is better" mentality is invoked, expensive items have higher visibility and are thus more are purchased. Ironically, most weapon systems become inoperable not due to repairs that require an engine replacement, but ones that require parts costing less than $100.00. But there continues to be the mindset that the more engines that are on hand, the better off the Army is.

A subset of this problem is the question of what to do with the present inventory that the RBS model recommends not to stock. Many General Accounting Office (GAO) studies have identified that all the services, including

the Army, have spares on hand in excess of necessary operational requirements. If the Army could return the spares to the suppliers for a credit, the Army may only get pennies on the dollar for them [Ref. 12].

The Army must also be aware that large on-hand inventories have a tendency to mask additional problems, such as unknown customer demands and lack of inventory training. An analogy that can be used is a stream full of rocks. The water in the stream represents inventory flow and the rocks represent potential problems. The water in the stream hides the variability and problems. Because the problems are hidden by the inventory, they are sometimes hard to find. By reducing the inventory, management can expose the problems and chip away at them until the stream is clear.

During a brief to the Deputy Chief of Staff (Logistics), AMSAA provided a chart that they believed was the most effective way to convince management to use RBS in the active Army. AMSSA showed that the Army Material Command (AMC) had about 600,000 NMCS records to restore an end item to operational capability, of which 75 percent of the backordered requisitions were for parts under $10.00 [Ref. 13]. There is a likelihood that the costs to manage each of these small dollar requisitions are more than $10.00 because the requisitions were sent to an outside source of supply rather than the Army retail supply level. With the Army's present add/retain criteria, these low demanded parts would not be on the ASL. The way this problem can be solved is take one of the $500,000 engines

and buy 50,000 of these \$10.00 NMCS requisitions and thus drive the back orders to zero. AMSAA believes that if they can get people to understand the need to move to RBS, the Army may be able to achieve 90 percent operational availability for any end item.

The second reason for the Army's apprehension in accepting RBS is the belief that the commanders are losing control in stocking decisions. In the Army, individual units maintain inventories of various spares. The individual commanders provide personal experience and make recommendations based on their experience to manipulate the requisitioned objective.

The possibility also exists that apprehension in accepting RBS in the Army, even though numerous fielded demonstrations were completed with positive results, is caused by the lack awareness and understanding of what RBS is and how it works. Army officers who have served in the Quartermaster Corps at best only vaguely know of the RBS concepts. Misunderstanding of RBS can lead to invalid assumptions and inappropriate conclusions concerning its implementation.

I. SUMMARY

For the past eight years, AMSAA has been trying to implement RBS as the primary spares requirements model for the Army. Furthermore, AMSSA has on numerous occasions briefed the Deputy Chief of Staff, Logistics, explaining the rationale for the move to RBS methodology. Field demonstrations were

completed providing improved supply performance in the areas of fill rate and demand accommodation.

The main reason for the Army's resistance to implementing RBS is the lack of understanding and knowledge of the concepts and methodology of RBS. Despite all the briefings and field demonstrations, communications throughout the Army about RBS is lacking. As pointed out, many of the personnel who should be involved in RBS are the ones resisting the move to this methodology because they do not understand it and have not been trained about its concepts.

The lack of communication throughout the Army is partially due to the lack of education between and within subordinate commands. With a paradigm shift in inventory management of this magnitude, simple briefings will not bring an absolute change in Army inventory thinking. Subordinate commanders must also be briefed by AMSSA on RBS. Once an understanding at this level is established and commanders are on board, then RBS may come to fruition. Acceptance of RBS by commanders would lead to training programs on accurate data collection and a concerted effort by the Army to satisfy the data requirements that are needed to comply with RBS models which would in turn provide for higher weapons systems availability.

IV. MARINE CORPS MOVE TO READINESS BASED SPARING

The Commandant of the Marine Corps, General Krulak, set out the goals for Precision Logistics in his White Letter No. 01-97. In a passage from the White Letter:

> Precision Logistics will be the vehicle by which we will sustain the Marine Corps of the 21st century. By adapting the best commercial practices and leveraging proven technology advances, Precision Logistics will provide responsive and reliable support to the Fleet Marine Force (FMF) at home and across the full spectrum of expeditionary operations. Precision Logistics provides the decisive support our Marine Forces need by substituting process improvements, asset visibility, and a customer-oriented distribution system for the current costly, inflexible and cumbersome one. More than a set of procedures, Precision Logistics will lead to a cultural and paradigm change in the way we think and operate [Ref. 16].

To support these efforts and the premise of Precision Logistics, the Deputy Chief of Staff, Installations and Logistics (I&L) chartered various studies performed by CNA in evaluating the present supply support systems and the ease to switch over to an RBS methodology. The studies concluded that the Marine Corps has a difficult road ahead. The most demanding challenges are Marine Corps logistical information systems and the requirement for data. In this chapter, discussion will encompass the problems with logistics information systems that the Marine Corps presently utilize and data collection.

A. LOGISTICAL INFORMATION SYSTEMS

The data necessary to support RBS is derived from four sources: the Marine Integrated Maintenance Management System (MIMMS), the Supported Activity Supply System (SASSY), the Applications File, and the Marine Corps Readiness Evaluation System (MARES).

1. Marine Integrated Maintenance Management System (MIMMS)

MIMMS records all organic and intermediate level maintenance actions performed on end items. Maintenance personnel use the system to record all the equipment repair orders (EROs) that were opened to bring the inoperable end item back to operational status. EROs consist of the national stock number (NSN) unit of issue, quantity, and document numbers of the repair parts that are required to bring the end item back to its operational status. This system records the date the requisition was submitted, any transactions against the requisitions such as status, and the date when the supply section received the parts. Accuracy of this data is very important to any form of sparing models.

Data from this source can derive usage rates, repair rates, item demands, and repair times for reparable components for particular end items. The key problems inherent with this data source, as described by Anne Hale, was that the current usage rates were not tied to a specific end item and the usage rates were based on peacetime data [Ref. 17]. Second, the repair rates do not extend to all

levels of indenture for the end item, and it is difficult to determine if the component was repaired or inducted into the next echelon of maintenance [Ref. 18]. Third, RCT does not extend to all levels of indenture. To repair these problems, indenture structure for all end items must be resident within the system. This would then compensate for the lack of RCT and usage being tied to specific end items.

2. Supported Activity Supply System (SASSY)

SASSY contains the inventory management and requirement determination codes that are used for calculating requisitioning objectives for peacetime reparable and consumable stocks [Ref. 18]. The main problems identified by Anne Hale are that this data source is difficult to understand and use. Stock quantities are listed under different headings and different places from where the item is physically located. Also, the file does not contain a component list with a corresponding inventory quantity [Ref. 17].

3. Applications File

The Applications File contains end item configurations data and indenture relationships between the end item and its components. This file was identified as inaccurate and does not contain the mission critical components essential to a multi-indentured RBS inventory model. The alternative to this file is to comb through the technical publications for each end item and piece together the mission essential components.

4. Marine Corps Automated Readiness Evaluation System (MARES)

MARES is the Marine Corps system that records the operational status of selected end items as reported by the Marine Forces. MARES provides historical measures for readiness which are measured by "R" and "S" ratings. "R" is a measurement of how many particular end-items are operational and are available at a specific location. "S" measures how many end items a specific location possesses and compares the number of end items that location is authorized to possess [Ref. 17].

B. MARINE CORPS DATA REQUIREMENTS FOR READINESS-BASED SPARING MODELS

In all of the chartered Marine Corps studies completed by CNA, CNA has concluded that the Marine Corps will have difficulties migrating to a RBS methodology because data contained in its information systems are neither accurate nor complete enough to support the more extensive RBS model data requirements.

1. Weapon System Data

Weapon system information is not required for demand-based sparing, but is necessary to support RBS models. Current Marine Corps logistical information systems do not capture the detailed weapon system data elements necessary to take full advantage of such models. The weapon system data elements that must be

captured include indenture structure, end-item criticality, end-item density, and end-item usage.

a) Building Detailed Indentured Structures

Indentured structures, as shown in Chapter II, are required inputs that are important to RBS because they identify the components of end items in terms of their contribution to a system's availability. The indentured structure of an end item is generally obtained through the acquisition process as part of provisioning data. Often this provisioning data is neither accurate nor updated on any time interval.

The Marine Corps uses provisioning data from contractors in building the Applications File, which is a database maintained at Marine Corps Logistics Base (MCLB) Albany, Georgia. It contains end-item configuration data and indentured relationships, but currently the Applications File only provides a single level of indenture; that is, it only associates a repair part to its end-item, not to the assemblies and subassemblies [Ref. 4]. Therefore, the indenture structure for Marine Corps end items is both inaccurate and incomplete. John Ivancovich and Brian Butters identified three data fields present within the Applications File, such as item designator number (IDN), IDN "consists of", IDN "part of" and indentured code; however, these fields, presently, are inadequate to develop the basic indentured structure to support RBS [Ref. 18]. These fields can support

RBS, but they must be overhauled and the correct data for all end items must be inducted.

Through numerous interviews with CNA personnel, it was recommended that the Marine Corps take control of developing indentured structure for all of its end items. This structure for all end items currently exists within technical publications in the form of diagrams; this information needs to be incorporated in building an indentured structure. To incorporate all end items with the thousands of associated parts would be monumental task. CNA recommended taking the Army approach of grouping or prioritizing end items as referred to in Chapter III. Prioritizing end items can be accomplished by using current Marine Corps classifications of end items as referred in Marine Corps Bulletin 3000. There are estimated to be 1,000 end items within the Marine Corps inventory. Of the 1,000 end items, 18% are deemed as mission essential. These end items should serve as candidates for RBS [Ref. 4].

Captain Penrose also suggested that once the prioritization of end items is completed, combat essentiality codes for the respective parts associated with the prioritized end items need to be established. It is also known within the Marine Corps that combat essentiality codes are lacking in correctness. A thorough review of the parts should be conducted and parts with combat essentiality codes of 5 and 6 should be spared from using RBS. Combat essentiality codes 5 and 6 are repair parts whose failure in a combat essential end-

item will render it inoperable or reduce its effectiveness below the minimum acceptable level of efficiency. Combat essentiality codes will be discussed later in this chapter.

The Army has already started to develop the indentured structure for grouping of end items. Since there is an 85% commonality in end items between the Army and the Marine Corps, coordination between the two services is required. The AMSSA's OSRAP model is only a single indenture, but interviews with AMSSA identified a need to have three levels of indenture. The Marine Corps is in a good position to gather the indenture structures for common end items already developed by the Army. Ultimately, the end item mangers for the Marine Corps and the Army must coordinate their efforts for the common cause. This creates a feedback mechanism to ensure the accuracy of information. To help the Department of Defense extract end item data, future acquisitions contracts should stipulate all indentured structure be provided in a data-readable format prior to the fielding of the end item. This format would facilitate the use of RBS at the System Commands.

2. Combat Essentiality Codes (CEC)

Ivancovich argues that combat essentiality codes must be overhauled. The CECs differentiate between parts that will render an end item inoperable and parts not critical to the operation of the end item. CECs are also the primary criteria in stocking inventories. Ivancovich further explains that the overhaul should not be

considered as an update but a complete change to reflect the current operational usage [Ref. 18]. When the overhaul of the CECs is completed, supply personnel would have a better handle in identifying the critical parts and also be able to make tradeoffs in providing the required support.

In reviewing the end items present in the Marine Corps inventory, a very high percentage is not solely managed by the Marine Corps. The Army and the Navy control most of the end items and are responsible for the CECs. These controlling agencies are known as the Primary Inventory Control Agencies (PICA). In order for the new codes to be overhauled and incorporated, the PICAs must be integrated in the process. Since the Army is having the same problems with the codes for common end items as the Marine Corps, coordinated efforts between the two branches must be established in developing the new code structure. If the Army continues to have problems with the required data overhauls in implementing RBS, then the Marine Corps must take the lead [Ref. 19].

C. FAILURE RATES

There are basically two types of failure rates: demand failure rates and operational failure rates. The Marine Corps currently uses failure rates based on demand data. The problem with this type of failure rates is that it does not accurately account for end item usage and density [Ref. 19]. Density refers to the

quantity of equipment being supported. Operational failure rates combine the demand failure rates and also the relevant factors required for RBS.

1. Demand Failure Rates

The Marine Corps' two logistical information systems that collect demand data are SASSY and MIMMS. SASSY demand is used to forecast consumable inventories, while MIMMS demand is used to forecast reparable inventories. MIMMS demand data is designed to flow through and be captured by SASSY. Therefore, the two files are designed to be equivalent [Ref. 4].

While attempting to develop operational failure rates, CNA compared the demand data between the logistics systems, SASSY and MIMMS, and concluded that the demand history for specific parts registered a different number of failures. For example, in MIMMS a particular repair part registered 14 failures, while in SASSY, zero failures were recorded [Ref. 4]. The magnitude of inaccuracies between the two logistics systems demonstrates a lack of integrity for all data.

A possible solution suggested by Capt. Penrose is use of only one system to capture demand data for inventory modeling. For example, the maintenance information system could serve to capture demand for RBS. RBS is concerned with capturing the demand for actual repairs made to end-items, which represents a closer match with the maintenance information system [Ref. 5].

In contrast, supply system demand is vulnerable to distortion through various funding cycles, where purchases made are not immediately maintenance

related. For example, at the end of the fiscal year, a supply officer with year-end funding available may purchase a stockpile of tires to be prepared for a slow down in funding at the beginning of the next year. This year-end bulk purchase bears little relationship to the actual usage and consumption patterns of tires. Worse, the bulk purchase distorts actual demand. This would create havoc with an RBS model [Ref. 4]. This exact problem was sighted by the AMSSA in the previous chapter.

2. Operational Failure Rates

Presently, the Marine Corps does not capture operational failure rates. These rates must reflect the rate of failure of the part along with the duration, extent, and type of usage [Ref. 19]. How usage is specified and how failure rates are measured depends on the type and use of the part. For example, for tires, mileage is the appropriate measurement and hours of operation would be a measurement for headlights [Ref. 19]. It would be unrealistic to record the times the Marines used the headlights or the number of starts to measure the failure rate for starters. An easier measure, which is already available in MIMMS as an input, is using mileage for the components of a vehicle.

The first step in determining operation failure rates is to understand how current usage information is contained in the MIMMS EROs and whether the information is accurate and useable. Usage data is recorded whenever the maintenance management section opens up an ERO and the supply section enters

a requisition under the ERO. All usage is accumulated for all parts that were inputted with all EROs. For any given period of time, the total demand for a specific part, total end item usage, and operational failure can be computed.

In March 1998, CNA was chartered to study the accuracy of the usage. During the data collection research stage, they evaluated the MIMMS logistics system and the data that was input for specific serial numbers of High-Mobility Multipurpose Wheeled Vehicles (HMMWV). The HMMWV was selected because of its long service history of repair data. CNA collected information on 5,747 individual serial numbers and 48,712 records. They found that 69% of the vehicles had erroneous information [Ref. 19].

In MIMMS there is a field currently present to capture data mileage for the vehicle being repaired. For the ERO to be closed when receipt of parts and repairs are completed, the Marine must input the mileage. Often the Marines input erroneous number into the mileage data field. Examples were provided of vehicles that were reviewed by CNA. In referring to the appendix, the upper left side lists the various serial numbers. The lower right lists the Day Received in Shop (DRIS). The DRIS is the date that the vehicle was inducted into maintenance. The mileage input in the DRIS is the erroneous input identified by CNA. In reviewing the mileage, it is clearly evident that the Marines that input the data did not do it accurately. When the data is accurate, the system is able to provide information to supply managers on the mean time between failure for

components in the vehicle. Concurrently, if the Marines input accurate data for all the vehicles throughout the Marine Corps, the system managers located at MCLB Albany, Georgia would be able to provide the MTBF for various components. It is true that all components do not break yearly, but information can be gathered over an extensive period of time to accurately portray the MTBF. The reason that CNA provided for the inaccurate data is that the present demand based sparing models that are employed do not require accurate mileage information.

When all data is input accurately, MCLB Albany can collect the information, on a yearly basis, and provide Marine units with estimated MTBFs for components and consumable repair parts. Maintenance and Supply Officers can then use this management information to assist in preventive maintenance of the vehicle. As mentioned in the previous chapter, the Army has a system established for war reserve data collection, FEDC, but does not have a present means for collecting garrison data. Since MIMMS is already established with this data field, the Marine Corps can provide garrison information to the Army.

Information technology can help in this area. Currently, end-item usage is entered by a mechanic manually filling out an ERO. Often the ERO is completed in an office separate from the maintenance shop floor causing a time lapse before the information is recorded. Additionally, there is no check to ensure the information is entered correctly. This problem could be corrected by automating the ERO process, via computer terminal, on the shop floor, with the entire repair

history of the end-item recorded in a database and made accessible as soon as the ERO is entered electronically. With this, end-item usage could be instantly validated [Ref. 4].

D. SUMMARY

Much of the inaccurate data can be attributed to poor maintenance and supply data collection, but this does not provide solutions to the problem. Some solutions can range from training and incentive evaluations. CNA states that the data that is necessary is not resident in Marine Corps logistics systems because the Marine Corps does not use RBS [Ref. 18]. The data that is collected for the present system is sufficient. The data fields that are inaccurate are not important with the current system and motivation to get the accurate data is not present. When the Marine Corps moves to an RBS methodology, there will be an emphasis placed on correcting the inaccurate data collection techniques.

V. IMPLEMENTING RBS IN THE MARINE CORPS

> *There is nothing more difficult to take in hand, more perilous to conduct, or more uncertain in its success, than to take the lead in the introduction of a new order of things.*
>
> Niccolo Machiavelli, *"The Prince"*

This chapter develops the steps necessary for implementing a change to RBS in the Marine Corps. In moving to RBS there will be expected resistance to change. The most important concepts for combating resistance to change are setting the direction for the planned change, aligning personnel with the need for change, motivation, and establishing a partnership with the Army.

A. PROPOSED STEPS FOR THE IMPLEMENTATION OF RBS

1. Improve Current Processes

The first step in the implementation process is a review of the logistics information requirements, failures rates, and combat essentiality codes that need to be conducted by the Deputy Chief of Staff of Installations and Logistics (I&L) and AMSAA. The results of a review of the logistics information requirements would be the development of an I&L policy. This policy would allow those responsible for the collection of supply and maintenance data to support the current process and which are also required for RBS [Ref. 18].

Despite the shortcomings identified by CNA with end item usage data, training and motivation needs to be provided for those Marines responsible for the

collecting and input of data. MIMMS contains the necessary data prompts, such as mileage for vehicles and hours for engineer support equipment, to support the collection of relevant information on the required repairs of end items. Additional emphasis needs to be placed on correct data input.

With the accurate input of the required variables, the Marine Corps would then be provided a mean and a normal distribution, of time between failures for various components. This information is essential because it would give inventory managers an average failure rate for components during peacetime operations. For wartime data collection, the Marines can evaluate the data that is collected from the Army's FEDC. If apprehension exists about using the FEDC, the Marine Corps can develop a single test site during a Combined Arms Exercise (CAX) at Marine Corps Air Ground Combat Center (MCAGCC) at Twenty-nine Palms, California.

Overhauling combat essentiality codes for end item will be a time intensive task. For many of the weapon systems that the Marine Corps has in their inventory, the Primary Inventory Control Agency (PICA) is the Army. The PICA is the responsible agent for all information pertaining to weapon systems combat essentiality codes. If the Marine Corps singularly overhauls the codes, the Army, also being the PICA, must ratify the codes and adopt the same codes for their weapon systems. Since the Army is having the same problems in this area, Marines and the Army can jointly solve this problem. CNA suggested that if the

Army does not get on board with the developed combat essentiality codes, then the Marines should "drive the train" [Ref. 18]. This approach would be self-defeating. A partnership between the two services must be established at the ground level if implementation of RBS is to become realized for both services.

2. Improvements In the Logistics Information

This step encompasses changes that would affect logistics information that would be specific to RBS. This process would also capitalize on and benefit the improvements resulting from the first step, improving the current process. In improving the logistics information, which involves MCLB Albany, MISCO, and the Supply Battalions, heavy influence is placed on the development of indentured structure, end-item readiness and cost goals, and data collection improvements in data fields present in the current system, which are also a prerequisite for RBS.

The accurate development of the indentured structure for any weapon system is the bedrock of logistics information. The indentured structure for all current weapon systems must be developed and continually updated to reflect configuration changes. Concurrently, all new weapon systems those are presently going through the acquisition pipeline should have indentured structures developed prior to the end-item being placed in service. Marine Corps Systems Command (MARCORSYSCOM) must be involved in the development and require contractors to submit detailed indentured structure for all weapon systems. In the future, the request for weapon systems indentured structure should be

included in the Operational Requirements Document (ORD). The ORD identifies the Marine Corps requirement for specific weapon systems.

The indentured structure must include the hierarchical list of each subassembly by NSN, the quantity of each subassembly and component, a list of alternative subassemblies, and combat essentiality codes for each subassembly and component [Ref. 18]. The PICA must also be included in the development process of indentured structure.

Readiness and cost goals need to be established, ultimately by the Commandant of the Marine Corps, for all weapon systems. This process can start by reviewing the weapon systems within Marine Corps Bulletin 3000. This bulletin lists all items that the Marine Corps deems as critical and required for combat operations. At this point, the Deputy Chief of Staff for Installations and Logistics must take the lead in briefing all senior officers on the need for readiness and costs goals and prioritizing these weapon systems.

Improvements must also be made in the supply and maintenance data for all end items. The specific supply and maintenance information that needs to be improved is the same RBS data fields that were mentioned in the first step. The data requirements for each subassembly, component, or piece part failure rates, LRT, which includes backorder times and procurement lead times, RCT, SMR codes, and cost and accounting data must be gathered [Ref. 18].

3. Asset Tracking Logistics Asset and Supply System (ATLASS) Integration

The final step in the implementation process is full and seamless integration of the RBS required data fields with the current development of the newest version of ATLASS. The result of the review of the logistics information as proposed in the first step of implementation must be incorporated into the development of ATLASS [Ref.18]. Furthermore, the improvements in the supply and maintenance data collection during all steps of the proposed implementation plan must be fully supported by ATLASS. Having two stand-alone systems, one for RBS and the other for ATLASS, would hinder implementation and acceptance of RBS. This was evident in the Army's implementation of RBS.

B. A TIME FOR CHANGE

The implementation plan treats problems identified during interviews and from analysis of studies completed by CNA and AMSAA. However, change succeeds only when the entire organization participates. To develop a plan only takes one person, but to implement a plan takes the leadership of many.

In "*Implementing Change*" Todd Jick explains that an organizational change effort can be broken into three categories. The first category includes change strategists who are responsible for identifying the need for change and creating the vision. In the case of RBS, the change strategist is the Secretary of Defense who, in 1985, directed the Armed Forces to develop an RBS methodology and models to coincide with a weapons system management concept. The second

category is the change implementers who manage the day to day process and help shape change. The final category is made up of change recipients, primarily the first line supervisors and their staff, who are the largest group within the organization that must adopt and/or adapt to the change.

In management literature, “authors portray change [as] a bounded, defined, and discrete process with guidelines for success.... [Ref. 20]. In other words, change is a step-by-step process that leads to a successful implementation. However, this view of change is far from the truth. Many managers discover that change can be fraught with chaos [Ref. 20].

In Jicks’ essay, he documented multiple studies that examined pitfalls in implementing change. Some of the key pitfalls listed were:

1) Major problems surfacing that were not identified beforehand;
2) Coordination of implementation activities (i.e., conferences, and committees) was not effective;
3) Training and instruction given to lower-level employees were not adequate;
4) Capabilities of personnel involved in the implementation were not sufficient;
5) Change agents failed to win adequate support;
6) Failure to involve all individuals affected by the change [Ref. 20].

In implementing a change to RBS, the Marine Corps must overcome these pitfalls.

C. A CASE IN OVERCOMING THE RESISTANCE TO CHANGE

During World War II at the height of beef rationing, Kurt Lewin conducted an interesting experiment that exhibited how to overcome resistance to change. The experiment was conducted to get the public to consume the cow's internal organs. Lewin set up the experiment using three methods to help determine the best way to alleviate the public's resistance to change. The first method consisted of one-sided communication without questions and answers by a lecturer providing information and rationale why the public should eat the internal organs. The second method consisted of two–way communication between the lecturer and the audience. This method provided the same information and rationale, but allowed the audience to interact and provide feedback in the form of questions or statements. The final method was to arrange the audience in a circle and generate a complete and free flowing discussion of the issue through the use of a facilitator [Ref. 21]. At the end of the experiment, the third method, the group that was personally engaged, brought about a positive change in accepting this new food. As shown with this experiment, resistance to change can be overcome, but the most important variables are free flow of communication and information.

It is common in the military to adopt Lewin's first method, where the briefer describes the proposed changes and how they will be implemented without any regard to additional problems that are foreseen by the audience. When the problems are identified, the implementation process is in full swing, and the

process is hard to reconcile. With the implementation of RBS the Marine Corps should adopt Lewin's third method. Dialogue between the facilitator, in this case I&L, is required, and the Marines in the fleet must understand and buy into the change to RBS.

D. LEADERSHIP

1. Setting the Direction

To make the fundamental changes from the present inventory management system to an RBS inventory management, the Marine Corps must first set a direction. The first step in setting the direction would be to develop a vision along with the strategies/plans for producing the changes needed to realize the vision of the future [Ref. 22].

In 1982, the vision of a weapons system management concept was developed by publishing the Juliano memorandum and then following up three years later with a directive by the Secretary of Defense requiring all services to adopt and implement the new concept [Ref. 1]. The progression to a weapons system management concept was needed due to the austere budgets and an emphasis on readiness. The services were caught off guard when they were told to develop and implement the methodology before the turn of this century. However, the vision took hold in the Air Force, who then developed various models and presently has surpassed the other services on RBS implementation. The Marine Corps, on the other hand, published MCO 4105.1B in 1990, but has

not progressed further. The use of Lewin's first method to communicate the Department of Defense's vision of a weapons system inventory management concept was a poor choice. When the vision was published by the Secretary of Defense, all the services should have been trained on the new concept and partnerships should have been forged.

In setting the direction for change to an RBS methodology, all elements in the Marine Corps will need to be involved. However, the impetus for setting the direction should originate from within Precision Logistics. As identified in Chapter I, Precision Logistics is the focal point for all logistics activities that would encompass better commercial business practices; it is also responsible for developing and modifying consumer level supply policy and its associated directives. Precision Logistics must be the facilitator during the implementation steps of RBS.

Given all the fundamental changes occurring in the private sector that will soon also occur in the military, a visible and influential individual must be identified with the planned change if it is to be successful. In the private sector this individual is classified as a "change agent", but in the military he/she would be classified as a "champion". Throughout this thesis, this individual will be identified as a change agent. For the Marines, the change agent should be a highly visible leader and who is identifiable in the logistics arena and throughout the Department of Defense. Obviously, s/he must be a proponent of RBS

methodology and a true believer in the need for change. S/he must also construct an appealing future state for the Marine Corps. The Deputy Chief of Staff for Installations and Logistics could be the ideal RBS change agent. As indicated in Chapter III, a change agent is not present in the Army. AMSAA has continually tried to get the Deputy Chief of Staff of Logistics to carry the torch for RBS, but has not been successful.

2. Aligning Marines

The first aspect of aligning Marines to accept RBS involves communication. Effective communication of planned change is necessary to garner the understanding and support of the Marines affected, directly or indirectly, by the changes [Ref. 23].

The Marine Corps should undertake a "bottom–up" approach in changing inventory management. This approach comprises bringing together the initiators of the change to RBS and the Marines affected by the change. Bringing these groups together can create an environment for effective communication. The goal in this approach is commitment to RBS and not merely forced compliance [Ref. 23]. The communication interaction among these Marines together should mirror Lewin's experiment and his use of the third method of open communication. Rick Ross echoes Lewin's third method when he states that groups must come together and dialogue with the intention of exploration, discovery and insight. In an atmosphere of dialogue, the group can challenge and surface assumptions, and

examines various sources of disagreement. Dialogue should improve the quality of the group's collective thinking and interaction

[Ref. 24].

To establish an atmosphere of dialogue and partnership in discussing the proposed steps to implement RBS, Precision Logistics should select a target audience consisting of technical experts and first line supervisors from all aspects of inventory management (data collection, information systems), AMSAA, financial management, and supply/maintenance support. In addition, any other representatives who can help implement RBS or who can block the implementation must also be involved. The cross section of personnel is required because the implementation involves making changes, in some cases fundamental changes, to the way the Marine Corps operates at all levels.

Dialogue at the conference should discuss the need for an RBS implementation plan and five key parameters:

1) Problems with the present inventory system;
2) Identification of specific problems of moving the Marine Corps to RBS;
3) Tasks that must be altered to provide the necessary data requirements for RBS;
4) Ranking of problems in the order of importance that could undermine migrating to RBS. Examples of potential problems include inaccurate data collection, lack of indentured structure for weapon systems, and inaccurate data field within logistics systems;

5) Categorization of problems according to major command responsibility such as indentured structure and combat essentiality code problems [Ref. 20].

This conference would provide validation and/or changes in the steps of the proposed implementation plan. It would also serve as an impetus for individuals to go back to their parent commands and solicit questions and provide answers to assigned problems. It is important that continuous dissemination of information about RBS implementation circulate throughout the Marine Corps. Information dissemination can range from Marine administrative messages to an internet web page.

A second result from the conference should be the establishment of a training team, composed of supply/maintenance and financial management personnel, with the prime responsibility for facilitating small group discussions of RBS, developing training seminars, and providing recommendations on how to better implement the change strategy.

3. Motivating Marines

People resist change for a variety of reasons. Often personnel have had negative experiences with change, are satisfied with the status quo, and provided poor communication about the change. On the other hand, people who have high achievement needs are more likely to embrace change. These same individuals are even more likely to accept change when there is a tangible payoff [Ref. 25].

Change is the function of leadership; leaders must generate highly energized behavior to cope with the inevitable barriers to change [Ref. 21]. Motivation ensures that barriers to change can be overcome and it is a psychological force that steers the direction of a person's behavior in an organization and affects a person's level of effort and persistence.

There are many motivational theories that study change, but one of the best known is Herzberg's Motivation-Hygiene Theory. This theory links the relationship of motivation and satisfaction. His theory states there are two types of factors in the work environment that tend to create satisfaction and motivation. Those increasing motivation includes meaningful work, recognition, achievement, and advancement. The second type of factors, called hygiene factors, include those factors that can dissatisfy individuals, such as pay, status, security and working conditions. Table 5.1, summarizes the two factor attributes.

Table 5.1. Herzberg's 2- Factor Theory [Ref. 26]

Hygiene Factors		Motivators
Dissatisfaction ⇨	No satisfaction ⇨	Job Satisfaction
* Pay		* Meaningful work
* Status		* Recognition
* Security		* Achievement
* Working Conditions		* Advancement

Within this theory two forms of motivation are also involved: intrinsic and extrinsic. Intrinsic motivation occurs when an individual performs an activity for

its own sake. The task itself is interesting and meaningful. Extrinsic type of rewards are of secondary importance. This form of motivation is linked with Herzberg' job-motivating factors: recognition, achievement and advancement. To help generate this form of motivation in Marines, training must be provided in RBS methodology and its advantages over the present system. This education should include a description of RBS, discussion of the advantages and disadvantages of a move to RBS and the problems associated with implementing RBS.

The dissatisfaction or hygiene factors are extrinsic to the job: pay, security and status. Extrinsic motivation occurs when activities are performed to attain a reward such as a meritorious mast, achievement medal, a day off, or to avoid an adverse consequence such as an unsatisfactory performance evaluation.

For the implementation of RBS to be successful and effective, the Marine Corps must be able to link a combination of these forms of motivation together in order to satisfy a Marine's basic needs to accomplish the necessary tasks assigned. It is also necessary for the Marines involved in the initial stages of RBS implementation to have their performance formally linked to a reward system. This system should not only include intrinsic motivation that front line supervisors provide in daily positive counseling, but also with extrinsic motivation for Marines to accomplish significant goals during the implementation process.

An additional way to motivate Marines to accept change is for them to participate in change and to build ownership of the change [Ref. 27]. Active participation in change also facilitates communication about the change and the reason the change has come about. If the Marines are involved in the change vice being coerced to make the change, they may foster and devise more efficient vehicles to collect the relevant data that is required for RBS. This situation is conducive to commitment, not just compliance.

E. ARMY INVOLVEMENT

As described in Chapters III and IV, the Army and the Marine Corps are having the same problems with data collection. As it has been shown, the Marine Corps relies heavily on the Army for supply support and overall management of weapon systems. It would behoove the Marines to include the AMSSA and elements of the Army's logistics activities in the steps for implementing RBS. AMSAA has made large strides in the past eight years in developing RBS models and overcoming their data collection problems. This places the Marine Corps in a superior position to capitalize from AMSAA's and the Army's experience. A partnership between the two services must be forged to better serve their respective customers and provide a unified direction in attaining the Department of Defense's vision of weapon systems inventory management.

F. SUMMARY

This chapter has discussed the need for a conference, with Precision Logistics as the facilitator and key personnel within the Marine Corps in attendance, to establish a dialogue on RBS implementation and the associated problems. The products from the conference should be a proposed plan of how to proceed with RBS data improvements and an initial assignment to implement elements of the plan.

The lessons learned from the Army's RBS implementation process are the need for open and continuous communication, a committed change agent, and methods to motivate soldiers to buy in to the change. The acceptance and adoption of these three concepts would help the Marine Corps effectively implement RBS. Finally, the Marine Corps must form a partnership with the Army. The problems that exist in both services, indentured structure for like weapon systems and combat essentiality codes to implement RBS, are similar. Due to this similarity, jointly working together and solving these problems would benefit both services and provide a stepping stone in achieving the Department of Defense's weapon system management vision.

VI. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

The demand for increased readiness of weapon systems will continue to put pressure on all the services in the future. With the likelihood of continuing austere budgets for the funding of operations and maintenance, more specifically the maintenance of weapon systems, the Secretary of Defense directed the services to manage inventories in relation to weapon systems. Presently, moving to an RBS methodology provides the answer to these budget woes. The RBS inventory model, unlike DBS, is a concept for a requirement's determination that associates spares to individual weapon systems in order to sustain a specified level of operational availability. RBS responds to the changing needs, priorities, and management-imposed constraints of a weapon system in the most cost-effective manner in order to ensure the readiness of the system is not degraded. Progressing to RBS is a complete paradigm shift from the DBS inventory model.

Examining the Army's implementation of RBS provides the Marine Corps with a benchmark in diagnosing the Army's problems along with its successes. The main reason for the Army's resistance to implementing RBS is the lack of understanding and knowledge of the concepts and methodology of RBS. Presently, AMSAA has not reversed its strategy in trying to get the Army to implement RBS. This is where the Marine Corps can capitalize on AMSAA's problematic strategy along with its successes.

This thesis also analyzed the studies completed by CNA to determine what problems the Marine Corps would encounter in progressing to RBS. CNA identified that much of the inaccurate data can be attributed to poor maintenance and supply data collection, but did not provide any solutions to the problem. Solutions to the problems can range from training to incentives. CNA relates the poor state of inaccurate data to training; however, data necessary for RBS is not resident in Marine Corps logistics systems because the Marine Corps does not capture the needed data with the current systems.

Finally, the Marine Corps can successfully implement RBS through the alignment of its personnel with the use of various forms of communication and feedback mechanisms, a combination of intrinsic and extrinsic motivation, and strong leadership beginning with the change agent and working down the chain to the front line supervisor.

B. RECOMMENDATIONS

1. Develop a Team to Thoroughly Study the Army's RBS Model and Conduct Tests

The Marine Corps should actively pursue Readiness Based Sparing as the premier method for inventory management. To start this process, the Marine Corps should form a partnership with AMSAA to understand the Army's problems and successes in progressing to RBS and analyze the Army's RBS model, OSRAP. The Marine Corps should test this model in order to validate the

reasons why a move to RBS would increase weapon systems readiness and cut costs.

2. The Marine Corps Should Implement RBS

The Marine Corps should start to form a working group to look at the requisite policy changes that need to take place in order to adopt RBS. RBS needs to be implemented in the Marine Corps today. All the Army field demonstrations that were discussed in this thesis, shows that RBS can improve weapon system readiness at the least cost.

3. Use Precision Logistics as the Mechanism for Change to Implement RBS

Since its inception as a concept and now as section within I&L, Precision Logistics has been in the forefront in adopting best commercial practices. It is recommended that Precision Logistics be the focal point for all training and implementation of RBS methodology within the Marine Corps. Precision logistics should be the representatives that work with the Army in solving the problems that plague both services in implementing RBS. Precision logistics must bring the entire logistics community together to establish a dialogue on how to progress to RBS and be the key force in overcoming the potential change barriers such as apprehension and the need for awareness and the benefits of RBS.

C. FUTURE

Future research should consist of taking the OSRAP model that the Army has developed and working with Dave Seibert, AMSAA, and importing Marine

Corps demand data from one of the Supply Battalions into the model. An analysis should then be accomplished, similar to AMSAA's field demonstrations with the same detail.

A second area of research should consist in the reconciliation of the two main logistics systems, MIMMS and SASSY. Since these two systems will be an integral part in implementing RBS, the Marine Corps must find answers to why the two systems, which capture the same data, provides different information on the same parts. If this research is not completed the Marine Corps will not succeed in implementing RBS.

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